Charge collection in STS silicon microstrip sensors at their surface layer*

I. Panasenko[1], *V. Dobishuk*[1], *J. Heuser*[2], *V. Kyva*[1], *V. Militsiya*[1], *Ie. Momot*[1,3], *V. Pugatch*[1], *and M. Teklishyn*[1]

[1]KINR, Kiev, Ukraine; [2]GSI, Darmstadt, Germany; [3]Goethe University, Frankfurt, Germany

To provide radiation tolerant devices for the CBM experiment (Silicon Tracker Station) prototypes of silicon microstrip sensors have been produced in two technologies. For the short-long stereo-strips connection, either double-metallization lines ("double metal" sensor) or a single-metallization design with an external microcable ("single metal" sensor) have been manufactured. We report here the results of studies performed for those sensors with the Pu (triplet) alpha-source and laser (640 nm wavelength). Both methods provide test of the charge collection at the sensor surface layer where double metallization is laid out. Measurements were carried out exploring discrete electronics and the fast-slow coincidences setup at KINR. This allows studying a charge sharing between adjacent strips of the silicon sensor hit by alphas or laser pulses. The degradation of the cluster finding efficiency in the vicinity to the double-metal connecting lines in heavily irradiated microstrip silicon sensors has been observed [1].

The CBM05H4 'double metal' and 'single metal' (HAMAMATSU) sensors were full depleted at 80 V. In a two-dimensional (E_i x E_{i+1}) energy distribution of events in adjacent strips 'i' and '(i+1)' three loci for a ^{239}Pu, ^{238}Pu and ^{233}U alpha-particles source are shifted by ~ 20 % to lower energies for the double metallization sensor in comparison with the single metal one. Also the widths of loci are larger. The evaluation shows that this could be explained by the alpha-particles energy loss and straggling in the SiO_2 isolation layer present only in the sensor with a second metallization layer. Biasing voltage scan has demonstrated expected performance for these sensor types, while CBM06C6 (CiS production) have shown appearance of the dead layer ($\sim$ 25 μm) in the interstrip gap at full depletion voltage.

Also measurements with a 640 nm laser beam (7 μm spot) scanned over the sensor area were performed for sensors irradiated at the KINR isochronous cyclotron up to the $2*10^{14}$ 1 MeV n_{eq}/cm^2. Figure 1 shows two dimensional distribution of amplitude of charges originated in the interstrip gap of the CBM05 non-irradiated sensor illuminated by the scanning laser beam. It demonstrates excellent position resolution achieved: beam spot position is indicated by figures of 15 μm, 18 μm, 21 μm etc. Figure 2 illustrates degradation of the charge collection by 30% in the irradiated sensor (the locus of laser events is shifted to lower amplitudes region). Analysis of data for other sensors is in progress. Tests with the ^{90}Sr β-source will be made soon exploring the 'ALIBAVA' microelectronics readout system.

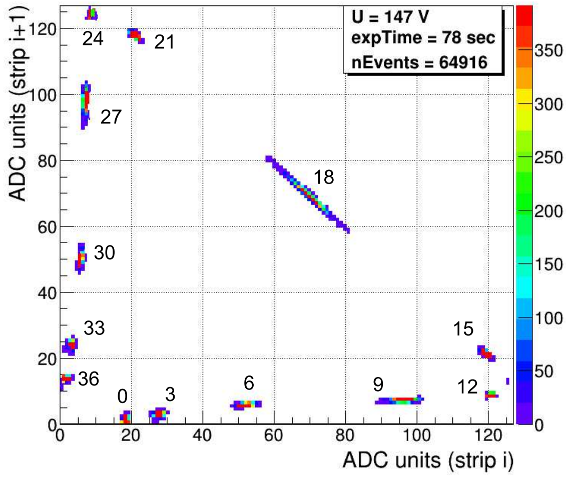

Figure 1: CBM05 – non-irradiated sensor: Laser scan in the interstrip gap.

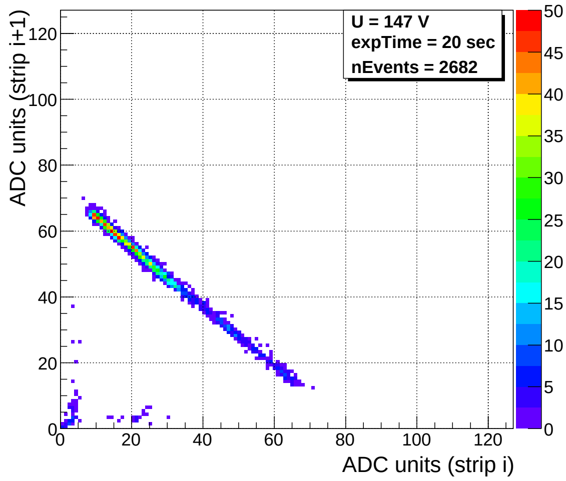

Figure 2: CBM05 – irradiated sensor: Laser scan in the interstrip gap.

References

[1] A. Affolder et al., Radiation damage in the LHCb vertex locator, JINST 8 (2013) P08002, arXiv:1302.5259.

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